Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

FORTY YEARS' ACQUAINTANCE WITH THE MICROSCOPE AND MICROSCOPISTS.

CHARLES E. WEST, LL. D., Brooklyn, N. Y.

I began my microscopic studies in 1842. In April of that year my Paris correspondent wrote me: "The microscope I have purchased for you is the best Chevalier has ever made; 'the most perfect,' he says, 'and complete.'"

More than two centuries before, lenses had been made. Drebbel, Jansen, Galileo, Hooke, Campani, Leeuwenhoek, Grundelies, Newton and others, were interested in improving them. In 1672, Newton invented the first compound reflecting microscrope. This form was afterwards improved by Amici, Tully, Cuthbert, and Goring: Lieberkuhn invented the solar microscope. In 1824 an important era in microscopic science commenced with the improvement by Dr. Goring and Mr. Cuthbert, of the reflecting microscope, discovered by Amici in 1815, and with the construction of lenses of precious stones by Sir David Brewster, Dr. Goring and Mr. Pritchard. The microscope with only a single lens was also brought to the greatest state of perfection by these gentlemen. Then followed the combinations of lenses, termed doublets and triplets, by the aid of which microscopical science was at once considerably advanced. Notwithstanding the great improvements which had taken place in the compound microscope during this experimental period of nearly two centuries, we find that it remained a comparatively feeble and inefficient instrument, owing, says Mr. A. Ross, to the increase in the chromatic and spherical aberrations occasioned by the great distance through which the light had to pass. The image formed by the object-glass was not a simple one, but made up of an infinite number of variously colored and variously sized images. Those nearest the object-glass would be blue, those nearest the eye-glass would be red; the effect of this being the production of so much confusion that the instrument was reduced to a mere toy, notwithstanding these errors were diminished to the utmost possible extent by the device of limiting the aperture of the object-glass, and thus restricting the angles of the pencils of light from the different points of the object. But this proceeding made the picture so obscure that, on the whole, the best compound instruments thus modified were inferior to the simple microscopes having but a single lens, with which, indeed, as Mr. Ross correctly states, almost all the more important observations of the preceding century had really been made.

The compound lens, it was seen, must therefore be reconstructed or thrown away. Achromatism had been discovered in 1729, by Chester More Hall, who in 1733 constructed and applied to a telescope an achromatic object-glass, having been led to its discovery by the study of the human eye, and by observing that two kinds of glass could be combined so as to refract light without decomposing it. Two of his achromatice telescopes constructed on this principle were for a long time in the hands of persons who were not aware of their full value, and Mr. Hall died without revealing the secret of their construction. In 1774, Euler proposed the application of an achromatic combination for the object-glass of microscopes. Holland denied the possibilty of doing what Euler proposed, but commenced a series of experiments which ended in accomplishing all that Euler had declared to be possible.

A work was published in St. Petersburg under the following title, "Detailed Instruction for Carrying Lenses of all Different Kinds to a Greater Degree of Perfection." It contains a description of the object-glass of such a microscope, of which the following is the substance: The object-glass will be composed of three glasses, the first and third of which will be of crown glass, and the second of flint. The focal distance will be half an inch and the aperture of the lens will be one-eighth of an inch. The least thickness possible should be given to the glass composing the lenses; the two of crown glass will be bi-convex, and the middle one bi-concave.

In 1784, Æpinus, and from 1800 to 1810 Monsieur Charles, of the French Institute, tried to achromatize small lenses, but were unsuccessful. In 1812, Sir David Brewster constructed a permanent achromatic object-glass by placing butter of antimony between a meniscus and a plano-convex lens of crown glass. About the same year Prof. Amici, of Modena, invented a reflecting microscope, which proved so useful as to lead him to lay aside his experiments on the refracting instruments; but this form of instrument soon fell into disuse, and Amici returned to his former experiments on the refracting achromatic object-glasses.

From this time, the great march of improvement in the construction of achromatic refracting lenses began. The successful experimenters were M. Selligues of France, Fraunhofer of Munich, Amici of Modena, M. Chevalier of Paris, and Goring and Tully of London. Selligues made an object-glass formed of four compound lenses, each consisting of two pieces, and which could be used either in combination or separately. Tully constructed an achromatic objective, with a focal length of nine-tenths of an inch, composed of three lenses and capable of transmitting a pencil of eighteen degrees. James Smith of London constructed a microscope stand with a double stage movement, a diaphragm and a disc or dark well for opaque objects; the first microscope known provided with a coarse and fine adjustment. Dr. Goring made the discovery that the defining power of the microscope depends upon its angle of aperture. In 1825 M. Chevalier made an achromatic lens of four lines focus, two lines diameter and one line in thickness at the center. In 1827 Amici exhibited in Paris a horizontal microscope, in which the object-glass was composed of three lenses superposed, each having a focus of six lines and a large aperture. It had also extra eye-pieces by aid of which the magnifying power of the combination could be increased. In 1829 a valuable communication was sent to the Royal Society by Joseph Jackson Lister of London, relative to the discovery of certain properties in the chromatic arrangement which had not been before observed. He formed a combination of lenses which transmitted a pencil of fifty degrees with a large field, correct in every part. This announcement has formed the ground-work of all the great improvements which have been made in the subsequent construction of achromatic object-glasses. Another improvement applied by Mr. Lister was the joining together of the plano-concave flint lens and the convex crown by means of Canada balsam. This he stated to be desirable, "as it diminished very nearly half the loss of light from reflection, which is considerable at the numerous surfaces of a combination."

About this time the London opticians, Powell, and Ross & Smith, began their distinguished careers. To Mr. Ross is due a most important improvement in the construction of object-glasses, which he describes as follows: "Having applied Mr. Lister's principles with a degree of success never anticipated, so perfect were the corrections given to the achromatic object-glass, so completely were the errors of sphericity and dispersion balanced or destroyed, that the circumstance of covering the object-glass with a plate of thinnest glass or talc disturbed the corrections, if they had been adapted to an uncovered object, and rendered an object-glass which was perfect under one condition sensibly defective under the other." The remedy he suggested for this defect consisted in separating the anterior lens in the combination from the other two. He effected the adjustment by sliding the outer tube containing the anterior lens upon the inner cylinder. This contrivance Mr. Powell improved by applying to it a screw collar, so that the desired correction could be secured with greater nicety. Mr. Ross adopted this improvement. I have two of his objectives, a one-fourth (1854) and a one-twelfth (1855), both with the screw collar. The first is not graduated; the second is divided into twenty equal parts. A one-sixteenth by Powell & Leland, in my possession, is divided into fifty equal parts. Mr. Ross, by the peculiar construction of his lens, obtained the enormous aperture of 135°, so that he could transmit large angular pencils of light.

In 1845, Mr. Powell devised a new way of mounting the body of the compound microscope; the year previous he had succeeded in making an achromatic object-glass of one-sixteenth of an inch in focal length, the first objective of so high a power ever seen in England. It is generally admitted that Hermann van Deyl, of Holland, in 1807, made the first achromatic microscope by putting a bi-concave flint glass lens between two bi-convex crown glass ones. This objective, however, was not corrected for spherical aberration. Fraunhofer's achromatic microscopes in 1811 were the first that were applied to scientific investigation. Fraunhofer's objective consisted of a single achromatic lens in which the two glasses were not connected, the convex side of the lens being turned toward the object. This lens had not a high magnifying power, and the field of view was small; but the image of the object was more distinct and more strongly illuminated than in object-glasses that were not achromatic. With Fraunhofer a new era in the construction of object-glasses commenced.

With this brief introduction I will return to my Chevalier microscope. Like Amici's, the tube containing the eye-piece was horizontally mounted. The lenses were triplets and had no sharp defining power. It was attached for use to the box in which it was packed. It was, in fact, simply a toy, and practically was good for very little. Nevertheless, it furnished amusement for leisure hours, and gave me the satisfaction of thinking there was no better microscope in the world.

Some five years later this delusion vanished. Dr. Henry Goadby, of the Royal College of Surgeons, London, came to New York, bringing with him his large collection of microscopes and microscopic objects, etc., and gave lectures in New York and neighboring cities, upon his favorite science of microscopy. He was an enthusiast, and inspired every one who heard him lecture with like enthusiasm.

For many years he had dissected minute animal and vegetable forms, and was an expert in the use of the instrument. He had dissected the nervous system of the *Cossus ligniperda*, and was made blind thereby for many months. He lectured on the structure and uses of the microscope; on the preservation of animal substances; on the dissection and mounting of animal tissues; on making wet preparations of animal substances, and on the preparation and mounting of opaque objects. Before his time little had been done in histology.

His stands, objectives, and general microscopical outfit, were mostly made by Powell & Leland, and Ross. In projecting images upon a screen he used an oxy-hydrogen microscope, devised by Cooper & Carey, of London, in 1852, who gave the first public exhibition on February 18, 1853, in which the oxy-hydrogen light was made to perform all that had been previously effected only with direct solar light.

In 1851 and 1852 Dr. Goadby spent some weeks at my house and taught me the use of the microscope. At my request he gave Powell & Leland an order for their large compound microscope with all its accessories. It was a year before this microscope was delivered at my house. Dr. Goadby was there when it came, and opened the package. It was all, and more than all, that we expected. The able opticians had surpassed themselves. With this instrument in hand, I was encouraged to enter upon the pursuit of my microscopic studies.

Dr. Goadby lectured before the physicians of Buffalo, and to their great satisfaction. He was afterwards chosen to a professorship in the Agricultural College of Michigan, and died a few years later.

In 1860 I removed from Buffalo, N. Y., to Brooklyn, N. Y., leaving my collection with the Female Academy. In the latter city I began to make my third collection. I found there many gentlemen, particularly physicians, who were interested in microscopy. Smith & Beck's stand were then in general use. A new star had just risen above the microscopical horizon—William Wales, whose objectives were then all the rage among collectors. Mr. Wales had acquired great skill in grinding lenses while in the employ of Smith & Beck, of London. He came to this country, and soon established himself in business, confining himself almost entirely to the manufacture of objectives. I gave him frequent orders, until at least a dozen of his objectives, ranging from a four-inch to a thirtieth, found their way into my collection. Many of these are first-class lenses to-day. Wales' objectives are so well known to most American microscopists that I need not enlarge on their excellent quality. He is still turning out good work, and has recently made a one-inch objective which surpasses any lens of this denomination in my collection.

The oldest American optician, and one whose lenses have acquired a world-wide reputation, was Charles A. Spencer, of Canastota, N. Y. Prof. Bailey of West Point, and Prof. C. R. Gilman, of New York, were the first to call attention to the excellence of his work. Eight of his objectives have been in my possession, the highest being an eighth. My first purchase was an immersion one-fourth, in 1873. My correspondent, an expert, into whose hands it was put to be tested, wrote me concerning it: "I was told it had resolved *A. pelucida.* I asked to let me try it. After one or two attempts I succeeded in getting a good resolution on a dry frustule, and after that on several others more difficult, some in balsam." This gentleman stated "that he had to use the lens at its full cover-adjustment, which advanced it to a one-fifth, and he found it would then bear a one-half inch solid eye-piece by Tolles quite well, and would also allow the use of Tolles' achromatic amplifier and draw-tube, giving some two hundred diameters, at which point it would still show the cross-lines on *A. pelucida* distinctly."

I have never had any other immersion one-fourth to try, but have resolved *A. pelucida* with a one-sixth Tolles of 130° aperture; and better still with a one-fourth. For illustration, I used the ammonia sulphate cell and sunlight, and for a condenser an achromatic lens, having a focal length of two and one-half inches, and threw the light at an angle of about 55°–60° with the optical axis of the instrument.

I have resolved this test diatom with every immersion lens I have tried upon it, ranging in power from the one-fourth I have referred to, up to a one-fiftieth, and also with the one-eighth and one-sixteenth dry fronts of Powell & Leland; also with Bausch & Lomb's dry one-twenty-fifth, and Beck's dry one-fortieth. The one-fourth is still in my possession and is worthy of all that has been said in its favor. The microscope stands made by Mr. Spencer were of the best quality of workmanship. There were several patterns; the earlier, like Chevalier's, were horizontally mounted. The others, his large trunnion microscope, for example, with double mirror, plain stage, movable stage, two extra arms for diaphragm, polarizer, etc., and with coarse and fine adjustments, was for that early time a marvel of mechanical skill. He made but three of these beautiful trunnion instruments, and one of them, and also one of the Chevalier pattern, are now in my collection. The trunnion instrument turns so as to enable it to take either a horizontal or a vertical position, or any intermediate inclination, which gives it a great advantage. It was about 1847 that Mr. Spencer entered upon his successful optical career.

Mr. J. Grunow, of Berlin, Germany, came to America in 1849.

In 1852 he constructed his first microscope. The next year he made the first binocular microscope from drawings furnished by Prof. Riddell. Later I ordered one, but it was not satisfactory; the prism did not divide the beam of light equally. Grunow's objectives were of excellent quality.

One of the most skillful opticians of the world was the late Robert B. Tolles, of Boston. Born of humble parentage, in a New England town, in 1822, Mr. Tolles spent his boyhood on a farm, getting such meagre advantages as were afforded by the district school. In 1843 he made his way to Western New York and engaged himself as an apprentice to Charles A. Spencer, and for twelve years he remained in his employ, and assisted in turning out the wonderful lenses which made the name of Spencer so famous. During this time, A. K. Eaton, now of Brooklyn, N. Y., was a partner of Spencer. He became interested in Tolles, and purchased a lathe precisely like that used by Spencer, and asked him to let Tolles have the formula for his one-fourth objective. Spencer was unwilling at first to part with his formula, thinking Tolles unable to make a one-fourth, but by long and urgent entreaty Spencer finally yielded and a lens was completed and presented to Spencer for examination and criticism. It met his approval and a second objective was finished which was better than the first. Tolles felt that his fortune was made. He soon after left Spencer and set up for himself in the same little village of Canastota, where he remained till 1867, when he was offered the position of superintendent of the Boston Optical Works, to which place he removed and where he continued to reside till his death, which occurred in 1883.

It was in Boston that Tolles made his great and deserved reputation. Here he invented all his formulæ. He was the first to make the so-called duplex objective; the first to show Noberts' nineteenth band with his own one-tenth objective, as Dr. Woodward was the first to photograph the same nineteenth band also with Tolles' objective. He was the first to make a really practical binocular eye-piece; the first to make short focus telescopes; the first to make solid eyepieces; the first to perfect the prism arrangement, by which the one-fourth objective could be used for illuminating opaque objects through its anterior lens.

Time would fail me to note all the inventions and improvements in optical instruments due to Tolles' inventive genius. He was as modest and unpretending as he was capable and successful. Strangers, it is true, could not readily gain access to him, but to his friends he was cordial and obliging. It is acknowledged, both at home and abroad, that amongst the distinguished makers of high-power objectives, he stands with the foremost.

Mr. Tolles' correspondence with me was of a very interesting character. November 13, 1876, he wrote me: "The one-twenty-fifth you have is a four-system objective, and the photograph was taken with a three-system one-twenty-fifth, *the very same* lens sent to Birmingham, England, on an order. I sent one other to London, but not to fill that order. I am perfectly willing to exchange even, such an objective as made the photograph, for yours; and I repeat what I wrote to you in my last, *viz.*, your one-twenty-fifth will not give a picture of *A. pelucida* so flatly as the three-system already referred to." This shows his preference for a three-system to a four-system lens for use in photography.

[Then follow several letters of Mr. Tolles and Dr. J. J. Woodward, which it is found necessary to omit on account of the length of this communication.]

Upon my own ground, in New York and Brooklyn, there have been many cultivators of our science. I may mention first the American Microscopical Society of New York, a society which was organized many years ago. John E. Gavit was its president and always actively concerned in its work; as was also its corresponding secretary, James W. Ward, for several years, and more recently president of the Buffalo Microscopical Club; also O. W. Mason, of Bellevue Hospital, a practical histologist and photographer, who photographed Dr. Rosenberg's scale of the solar spectrum, showing the metallic lines from E. to N., with correct measurement of their relative distances. I can only make this brief reference to the American Society. The Bailey Club was a vigorous and bright offset from it, consisting of John E. Gavit, E. N. Dickerson, Dr. J. J. Higgins, James W. Ward, Dr. Edward Curtis, Prof. Theophilus D'Oremieulx and Dr. John B. Rich; a select body of practical microscopists, who met at each others' houses from week to week, for studious work. They measured the high-power objectives of all the best American and foreign makers and found that many of them were overrated. They published a table of corrections. Dr. Curtis worked upon animal tissues and blood corpuscles. Dr. Higgins sought out experimentally the best method of showing diatoms. His lamp was a curiosity. By means of a concave lens introduced into the tube of his microscope and in front of his objective, Dickerson enormously magnified *P. angulatum*, representing the same in wood of the magnified size actually obtained; and this he accurately measured and photographed. The members of this club, in fact, accepted nothing on inadequate testimony; nothing which was not fully tested by themselves.

In 1871 this club invited Richard Beck of London to visit New York, and he came and was entertained by its members. He brought with him a large collection of lenses and other microscopic articles manufactured by his firm, which were exhibited at a reception given by Mr. Dickerson, among them a beautiful outfit of a large stand with all its accessories. Dr. Woodward photographed with this lens a frustule of the *A. pelucida*, on which he counted ninety-five striæ in the one-thousandth of an inch. This fine club, as did its parent society, finally disintegrated, to be remembered and regretted as things of the past. The present New York Microscopical Society was organized in 1878, and the Brooklyn Microscopical Society five or six years later. Both institutions are active organizations. The New York Society publishes its transactions monthly.

One of the most valuable periodicals of our science was, "The American Journal of Microscopy and Popular Science," edited by John Phin of New York. Alone, and by great personal effort, Mr. Phin conducted it for six years, from 1876 to 1882, but for want of the pecuniary support it should have received, the publication was discontinued; a great loss to its readers, who depended on it for the valuable information it gave from month to month. It is to be hoped that the old editor will be induced to revive the publication of his journal. When I began my studies there was not, to my knowledge, a microscopical society in the country; and there was no publication devoted to microscopy. Now societies exist in several, if not all, of our large cities, and there is an increasing demand for the best optical instruments, foreign and domestic. The microscope is finding its way into all our schools and colleges.

The interesting study of the Diatomaceæ, begun by Ehrenberg and our own Bailey, has been followed by many ardent students of these beautiful objects. Müller, Arnoth, Cleve, Febiger, Hamilton L. Smith, Edwards, Habirshaw, Ward and many others, are known as successful contributors to our knowledge of these minute forms of vegetable life.

I must allude here to Nobert's nineteenth band test-plate, the treasure and wonder of all microscopists; since it furnished an instrument of precise measurement for high-power objectives. It has not been superseded by any other ruled plate. The whole number of bands with the intermediate spaces occupied but one-seventieth of an inch space. The nineteenth band of the series has lines as close as 112,000 to the inch, making it a more difficult test than *A. pelucida*, which has only from 92,700 to 92,900 striæ to the inch. Nobert afterwards ruled a plate of twenty bands, the lines of the tenth band of which correspond to those of the nineteenth of the older plate. In this connection, also, I must refer to Mr. Lewis M. Rutherford, of New York, who constructed a machine for ruling on glass and speculum metal. The wheel of this machine was divided into 360 equal parts to the inch, and the advancing screw into forty-eight parts, which consequently enables the manipulator to cut 17,280 lines to the inch. The diffraction gratings thus produced are admirable for taking spectra of the sun and stars. I found one of them in use in Secchi's observatory in Rome; he was using it in his celebrated spectroscopic work upon the sun. Wm. A. Rogers' metric rulings on glass and steel and gold are also of great value to the physicist. This gentleman has ruled lines as high as 120,000 to the inch. His standard centimeters, half meters and meters, and his standard half inches and stage micrometers, are found already ine very well appointed working collection.

Charles Fasoldt, of Albany, has also done excellent work; producing plates with rulings as high as 120,000 lines to the inch. In 1877 I met in Rome, Count Castracane, a distinguished Italian nobleman, whom Secchi, the astronomer, charged with madness in his love of the microscope. He cordially received me at his palace, showed me his instruments and his photographs of the Diatomaceæ which he had taken,—a large collection,—and although they did not equal Dr. Woodward's in excellence, they were good. He afterwards invited me to pass an evening at his house, but unfortunately it was just as I was leaving Rome. I never met a more enthusiastic lover of our science.

In 1872, while passing my summer vacation in Buffalo, I amused myself with my microscope, making use of one of Zentmeyer's binocular stands. But after reading in an English publication some remarks in regard to the limitation of high-power objectives when used with the binocular arrangement,—it was stated that the one-fifth was the highest power that could be so used,—and having with me a set of lenses ranging from a one-fifth to a one-fiftieth, I tried the one-fifth on the *P. angulatum*, then the one-tenth, the one-fifteenth, the one-thirtieth and the one-fortieth, with perfect resolution, the one-fortieth resolving the frustule as perfectly as with a monocular. This was repeatedly done in the presence of friends who called on me, among whom were some of the officers of the Buffalo Microscopical Club. The next year, at a meeting of the American Society of Microscopists, in Buffalo, I was called on to make some remarks, and stated what I had been able to do with the binocular and high-power objectives. My statement was flatly contradicted by the president of the Society, who said "it never had been done and never could be done, since it was contrary to the laws of optics." I was mortified, but felt sure I could prove all I had said. Mr. Zentmeyer fitted a binocular to my monocular stand, but on trying it with my high-powers, I found it would not resolve any of the tests. I then went in search of the binocular I had previously used, which was a borrowed one, but it had been sold and all trace of it was lost. It would seem that the secret of success lies in the *equal* division of the beam of light by the prism of the binocular, so that like illumination in direction and intensity is supplied by both tubes. Failure in this respect has been found to exist in all the binoculars that I have tried, excepting in the one thus brought in question.

In 1875, Edward Bicknell, of Cambridge, Mass., spent several days with me and tried my collection of sixty objectives. We used Müller's 100-platen, and selected *Triceratium favus* for direct light, finding it a better test than the podura. The nuclei were shown best by Tolles' duplex one-sixth. Tolles' fiftieth did not show them, nor did Wales' thirtieth. They were seen, however, by Wales' one-fifteenth and Hartnack's No. 11. With Tolles' solid one-half inch eye-piece, none of the lenses would exhibit these nuclei, except Tolles' one-sixth and one-tenth objectives.

The tests for direct light used by Bicknell were *Heliopelta*, *Triceratium favus*, *Navicula firma*, and *Hylaodiscus stelliger*. For oblique light, *A. pelucida*, *Navicula crassinervis* and *Frustulia Saxonica*.

On February 5th we tried Tolles' one-fiftieth with blue cell and sunlight on the *P. angulatum* with direct light, and on *Surirella gemma and Frustulia Saxonica* with oblique light. I had never seen these objects in such perfection before. Tolles made a $\frac{1}{32}$-inch objective for Prof. Clark of Harvard College, registering a power of 3,500 diameters, with which Professors Wyman and Clark conducted their inquiries concerning spontaneous generation.

The next remarkable advance in high power lenses was a one-fiftieth made by Tolles for Dr. A. G. Harriman, of Boston, the discoverer of the nerve fibers in the soft solid matter of dentine, and of the fibrous or tubercular structure of dentine. Two years later Dr. Harriman commissioned Tolles to make for him a one-seventy-fifth objective, which he did. This lens has a working distance of only one-two-hundred-and-fiftieth of an inch; it cost $400. It has an angular aperture of from 173° to 178°, and is constructed on the three-system plan, the posterior pair being adjustable to cover. Dr. Harriman used glass covers one-two-hundred-and-fiftieth of an inch in thickness. This lens is available for photographic purposes and has, when properly illuminated, a moderately clear definition, but it will not bear eye-pieces higher than B.

Colored corpuscles of blood are so minute it would require about 2,500,000 of them to fill a circle of half an inch diameter. The apparent size of one of these corpuscles under this one-seventy-fifth objective is about that of a ten cent piece, so that its magnifying power, without amplifier, is not far from 7,500 diameters.

This is the only one-seventy-fifth objective Tolles ever made, and is now owned by Dr. Ephraim Cutter, of New York. The number of one-fiftieths made by Tolles was small, not over three or four.